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(54) Title: METHOD FOR DESALINATION AND REHABILITATION OF IRRIGATED SOIL

(57) Abstract

Method for the desalination and rehabilitation of irrigated soils through application to the soil of minute amounts of one or more anionic compounds having threshold properties in dilute aqueous solution.

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METHOD FOR DESALINATION AND REHABILITATION OF IRRIGATED SOIL

BACKGROUND OF THE INVENTION

This invention relates generally to soil conditioning and particularly pertains to a method for desalination and rehabilitation of irrigated soil.

Irrigated soil typically accumulates salts and alkalis that inhibit crop growth so that it becomes advantageous to remove the salts and alkalis to enhance crop yield.

Known techniques for removing salts and alkalis from soil are often expensive and relatively ineffective. One such technique termed "leaching" involves applying large amounts of water to saturate the soil and dissolve the salts and alkalis so that they leach down to the drainage tile and rise to the surface of the soil where they can be flushed away. Another technique known as "chiseling" involves raking the soil to cut deep furrows in order to break the hardpan underneath the soil to enhance the percolation rate so that water will not be left standing on the soil to evaporate and leave dissolved minerals behind. Yet another technique previously employed involves diluting lime-sulphur in irrigation water and applying the solution to the soil at a metered rate.

Such techniques suffer certain drawbacks. In addition to being relatively expensive and ineffective, the leaching technique tends to wash off fertilizers as well as percolating off the undesired salts and alkalis. Furthermore, it tends to cause the soil to settle and

pack together so that the soil needs to be reworked after the leaching. The chiseling technique not only requires the expense of a big chisel plow with a large tractor and the manpower and fuel involved, but it also is of a relatively short-term benefit and relatively ineffective to dissolve and remove salts and alkalis already existing in the soil.

Lime-sulphur applications, in addition to being relatively expensive and ineffective, involve the difficulty of dissolving the sulphur in the irrigation water.

It is therefore desirable to have a method for desalination and rehabilitation of irrigated soil which is relatively inexpensive, easy to perform, and effective to remove the salts and alkalis in order to enhance crop yield.

SUMMARY OF THE INVENTION

It is the primary object of the present invention to provide an improved method for desalination and rehabilitation of irrigated soil.

In accordance with the present invention, soil in which salts and/or alkaline components have built up from irrigation water is treated with very small amounts of certain anionic low molecular weight synthetic polymeric compounds and/or organophosphorus compounds in aqueous solution to inactivate or remove the salts and/or alkaline components and to improve the crop yielding ability of the soil.

I have found that certain anionic materials or their substantially neutral water-soluble salts applied to soil in minute amounts are effective to reduce the

harmful effects of salts and alkali which had accumulated in the soil from irrigation water. Thus soil in which such salts and alkali had reached the concentration that whitish deposits appeared on its surface and on which crop growth was unacceptably low is restored to useful fertility level through the action of these materials.

The material is applied in very dilute aqueous solution, suitably by incorporation in irrigation water to insure uniform distribution in the soil in depth.

The amount of active material required per unit area will depend on the extent to which salts and alkali have accumulated, but the amount is not in stoichiometric relation to the salt and alkali concentration in the soil. No exact figures can be given since the nature of the soil also affects the amount of active material required, but, for moderate salt and alkali accumulation in a heavy soil, useful effects have been obtained by application of from 0.1 pound to 5.0 pounds per acre over a 4 to 48-hour period, while for heavy accumulation, from 1.0 to 10.0 pounds per acre over a 12 to 96-hour period may be needed. The material is preferably applied in a plurality of spaced treatments to insure improvement of the soil in depth, and the treatments may continue in extreme cases until the soil is fully saturated.

Anionic materials having threshold activity suitable for use in the present soil treatment process include low molecular weight, water miscible synthetic polymers containing free carboxyl groups, organophosphorus acids, and substantially neutral salts of these. Threshold activity refers to sub-stoichiometric chemical processes

of which dispersancy and calcium carbonate stabilization are important factors. As described in Journal Of The Cooling Tower Institute, Vol. 3, No. 1, Winter 1982, page 17 et seq., in the article of Leonard Dubin entitled "The Effect of Organophosphorus Compounds And Polymers on $CaCO_3$ Crystal Morphology," calcium carbonate stabilization is understood to involve an increase in average particle size and a change in the gross shape of calcium carbonate crystals, and dispersancy involves surface charge effects.

Anionic polymeric materials for use in the present process include polymers, copolymers and sulfonated polymers and copolymers of acrylic acid, methacrylic acid, hydrolyzed polymaleic anhydride and substantially neutral water-soluble salts of these. The commercially-available material known as "Belclene 200", a product of Ciba-Geigy Corporation, of Ardsley, New York, which is understood to be a water-soluble hydrolyzed maleic anhydride polymer having a low molecular weight, e. g. from 300 to 5000, or salt or such polymer, has been found particularly useful (see U. S. Patent No. 3,963,636).

Organophosphorus agents for use in soil treating include phosphonic acids such as hydroxyethylidene diphosphonic acid, amino tri (methylenephosphonic acid), and nitrilo trismethylene triphosphonic acid, phosphinic acids such as phosphinocarboxylic acid, and substantially neutral salts of these acids.

These acids and/or salts may be used alone or in combination of two or more.

These materials can be used for the following methods of irrigation: border, basin, controlled flooding, corrugation, furrow, sprinkler, subirrigation, and drip.

The chemicals are diluted and proportioned with the flow of irrigation water to provide the desired dosage of material over a predetermined time and size of field to provide uniform coverage. Typical dosages fall between 0.5 and 4.0 pounds per acre. The compounds may be fed, depending upon the type of irrigation, using a chemical metering pump, passive drip, or holding tank and metering box.

These materials disperse and improve the solubility of mineral salts present in the irrigation water and already in the soil through stabilization and crystal distortion mechanisms and through dispersancy. This forces the mineral salts deep into the soil where they are eventually discharged through the field tile drains, resulting in an improved percolation rate, reduction of soil salinity and pH, and increased germination and yield.

It is to be understood that this proposed mechanism is advanced only as a possible assistance in understanding the invention and that patentability is based on the novelty and utility of the process and not on the correctness of the mechanism proposed.

The following examples are given to aid in understanding the invention, but it is to be understood that the invention is not limited to the particular procedures, conditions or materials of the examples. In each case there was noted an increase in the percent of seeds germinated as well as an increase in the rate of germination,

that is the seeds began to grow more rapidly and in greater numbers. Also, there was noted an improvement in the percolation of the soil as evidenced by a marked increase in salinity and flow of water through drain tile. Furthermore, there was a very evident removal of encrusted salt on the soil surface. Each example is representative of other experimental treatments performed on Imperial Valley agricultural land in Imperial County, California.

EXAMPLE I

A 35-acre sugar beet field in Imperial Valley was noticed to have 50% to 60% germination prior to treatment. It was watered twice using the method of the instant invention with 2-1/4 pounds of Belclene 200 per acre, each watering being about 24 hours in duration and spaced about five weeks apart. The first watering was a sprinkler irrigation to germinate the seed, and the second was flood irrigation. The typical results described above were noted following the treatment with as much as 90% to 95% germination. The adjacent field, which was watered at the same rate and manner but without treatment, was used for comparison purposes, and where it used to provide a yield more than double the production of the field that was treated, the productivity of both fields are not about equal.

EXAMPLE II

200 acres of a brand new field of alfalfa in Imperial Valley was watered twice, the first being a sprinkler irrigation before seeding at about 3 pounds per acre, and the second being flood irrigation about six weeks later at about 1-3/4 pounds of Belclene 200 per acre with the

same typical results described above in comparison to an adjacent field which was watered at the same time.

EXAMPLE III

42 acres of asparagus were watered six times at about ten-day intervals using about 1 pound of Belclene 200 per acre during each watering. The soil texture was visually improved, it having a better agglomeration as opposed to the much larger particle size in the adjacent field. Plants were greener after the treatment and much more vigorous in appearance in comparison to those on the adjacent field which even appeared brown in color.

EXAMPLE IV

A 10-acre spinach field was flood irrigated just after seeding with 2 pounds of Belclene 200 per acre. Germination was noticeably accelerated compared to an adjacent untreated field that was watered at the same time, and the germination period was only 50% to 60% of the normal time previously experienced before treatment.

EXAMPLE V

30 acres of bermuda grass was flood irrigated twice for 12 hours with about three weeks between waterings. 1 pound of Belclene 200 per acre was used in each watering, and now the bermuda grass is growing in soil that previously did not grow any bermuda grass.

CLAIMS

WHAT IS CLAIMED IS:

1. A process for reducing harmful effects of salts and/or alkaline deposits in soil which includes applying to the soil an aqueous solution of at least one anionic compound having threshold properties and/or the substantially neutral water-soluble salt of said compound.

2. A process as recited in Claim 1 in which said anionic compound or salt is applied in quantity of from about 0.1 pound to about 10 pounds per acre of land over a period of from about 4 to about 96 hours.

3. A process as recited in Claim 2 in which said anionic compound comprises at least one anionic polymeric carboxylic acid or its neutral water-soluble salt.

4. A process as recited in Claim 3 in which said anionic compound comprises at least one member of the group consisting of polymers, copolymers and sulfonated polymers and copolymers of acrylic acid and methacrylic acid, hydrolyzed polymaleic anhydride, organophosphorus compounds and substantially neutral water-soluble salts of these.

5. A process as recited in Claim 4 in which said aqueous solution contains from about 0.1 to about 10 ppm. of hydrolyzed polymaleic anhydride having a molecular

weight of from about 300 to about 5000 or its substantially neutral water-soluble salt.

6. A process as recited in Claim 4 in which said anionic compound comprises as organophosphorus compound or its substantially neutral water-soluble salt.

7. A process as recited in Claim 6 in which said anionic compound comprises a phosphinate or its substantially neutral water-soluble salt.

8. A process as recited in Claim 7 in which said anionic compound comprises at least one member of the group consisting of hydroxyethylidene diphosphonic acid, amino tri (methylenephosphonic acid), and nitrilo trismethylene triphosphonic acid and substantially neutral water-soluble salts of these.

9. A process as recited in Claim 6 in which said anionic compound comprises a phosphinate or its substantially neutral water-soluble salt.

10. A process as recited in Claim 9 in which said anionic compound comprises phosphinocarboxylic acid or its substantially neutral water-soluble salt.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US84/01756

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. Cl. [3] C05G 3/04; C09K 17/00
U.S. Cl. 71/27, 903; 405/264

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	71/27, 903 405/264

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 3,958,972 Published, 25 May 1976, Magin	8
X	US, A, 4,396,412 Published, 02 August 1983, Heller et al	1-10
X	US, A, 4,098,814 Published, 04 July 1978, Sommer et al	1-10

* Special categories of cited documents: [15]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
04 January 1985	[illegible] JAN 1985
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	Ferris H. Lander Ferris H. Lander

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